Drift Chambers:
The Science behind the Art

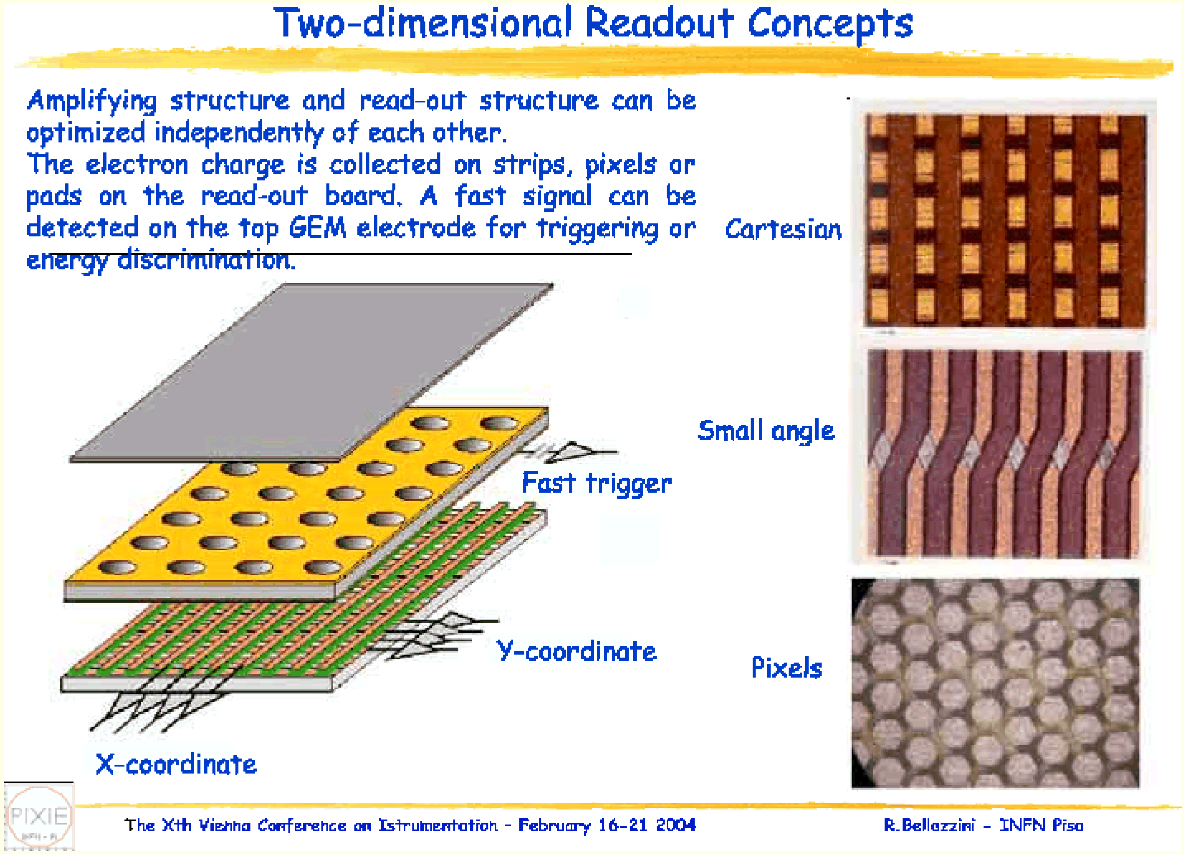
- What are they?   how do they work?
- ionization of the gas by particles
- “drifting” of the electrons
- the “avalanche” at the wire
- how tracking works
- frequently asked questions (**your** part!)

the **motivation** (you get to go to Vienna !)

there are alternatives!

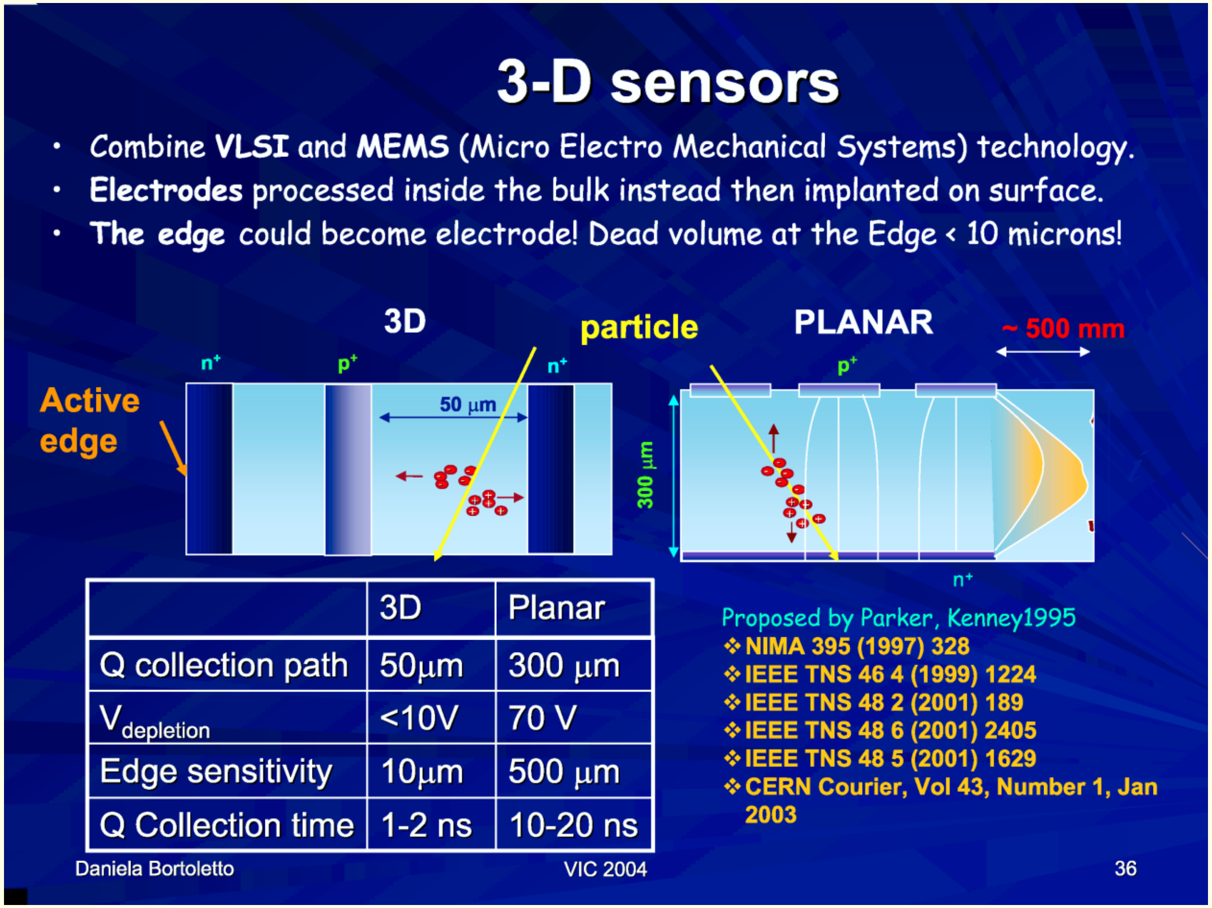
- Micro-pattern gas detectors
  - No wires to break, accurate patterns, fast ion clearing, anode at ground
  - Ideal for TPC’s; not as uniform as wires
  - Less multiple scattering than Silicon
  - Multi-GEM’s -> less ion feedback
    - more stable at same gain
  - shape of dielectric important
  - Micro-megas w/ resistive anodes
    -> competitive with GEM’s
  - Flexible readout schemes !

* Monolithic pixel detectors



from Bellazini's talk

New Types of Silicon Trackers



so why drift chambers ?

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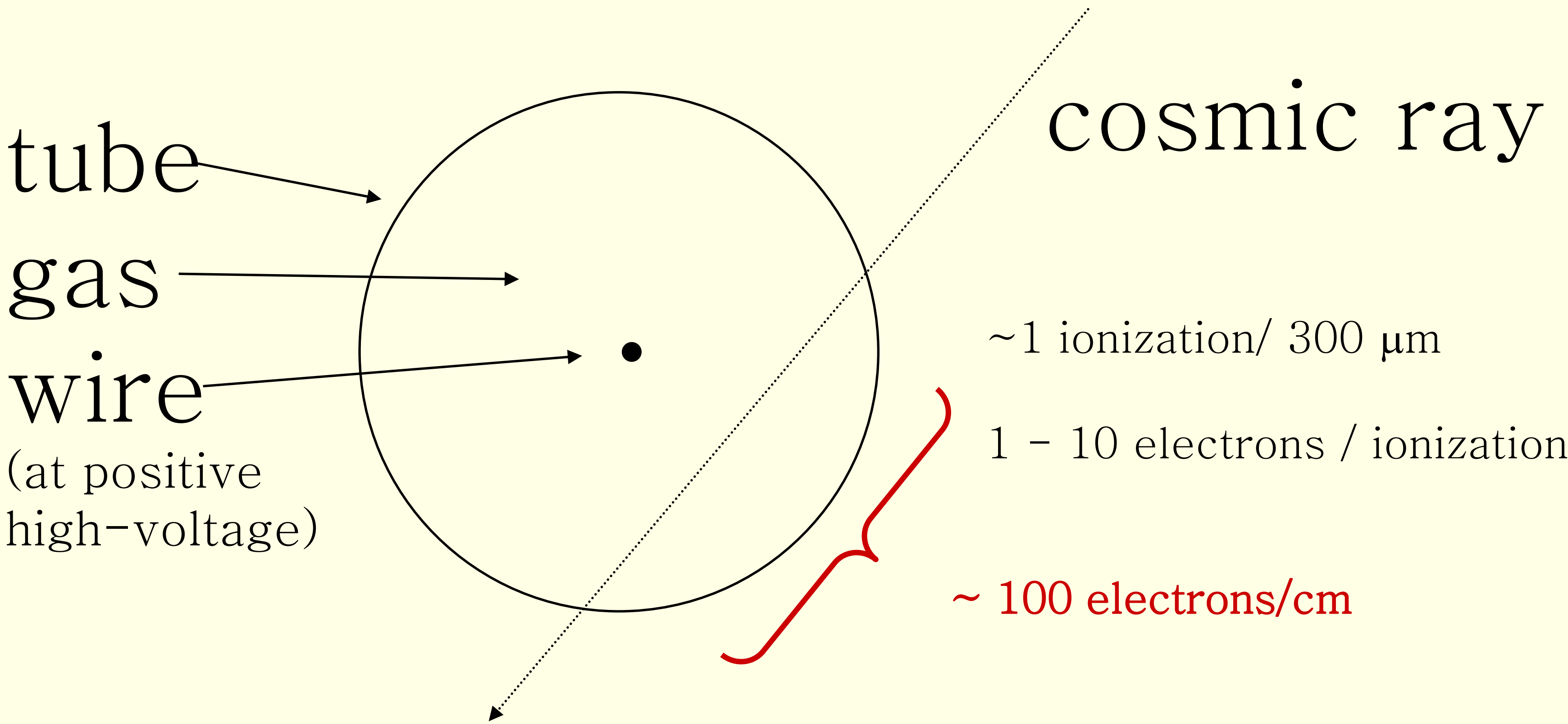
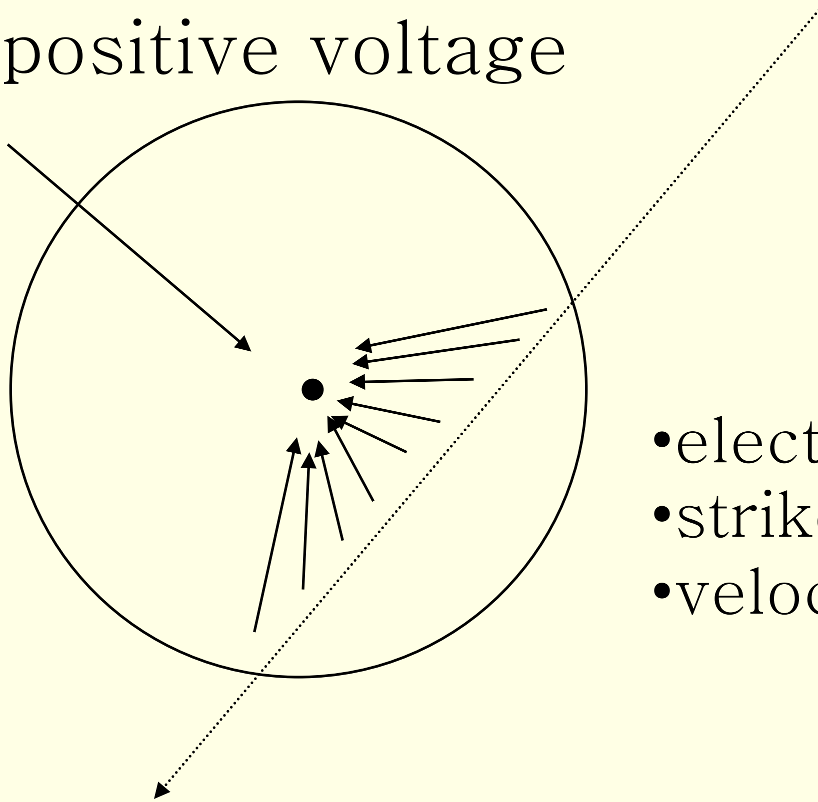
– economical way to cover a large volume with tracking chambers

gas ionization by particles



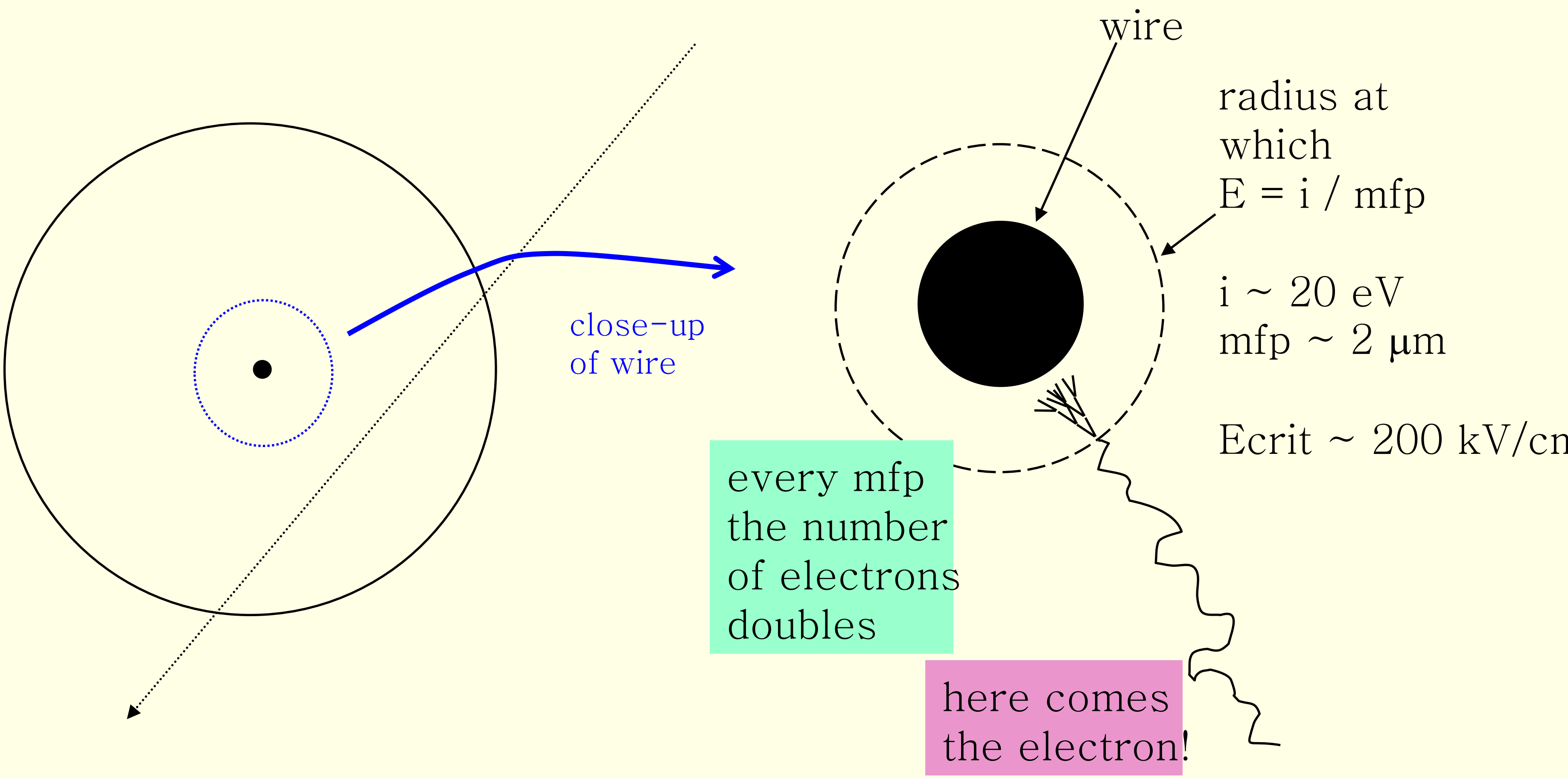
“drifting” of the electrons

wire at positive voltage



- electrons drift to the wire
- strike a molecule every 2 μm
- velocity ~ 50 μm/ns (max)

the “avalanche”

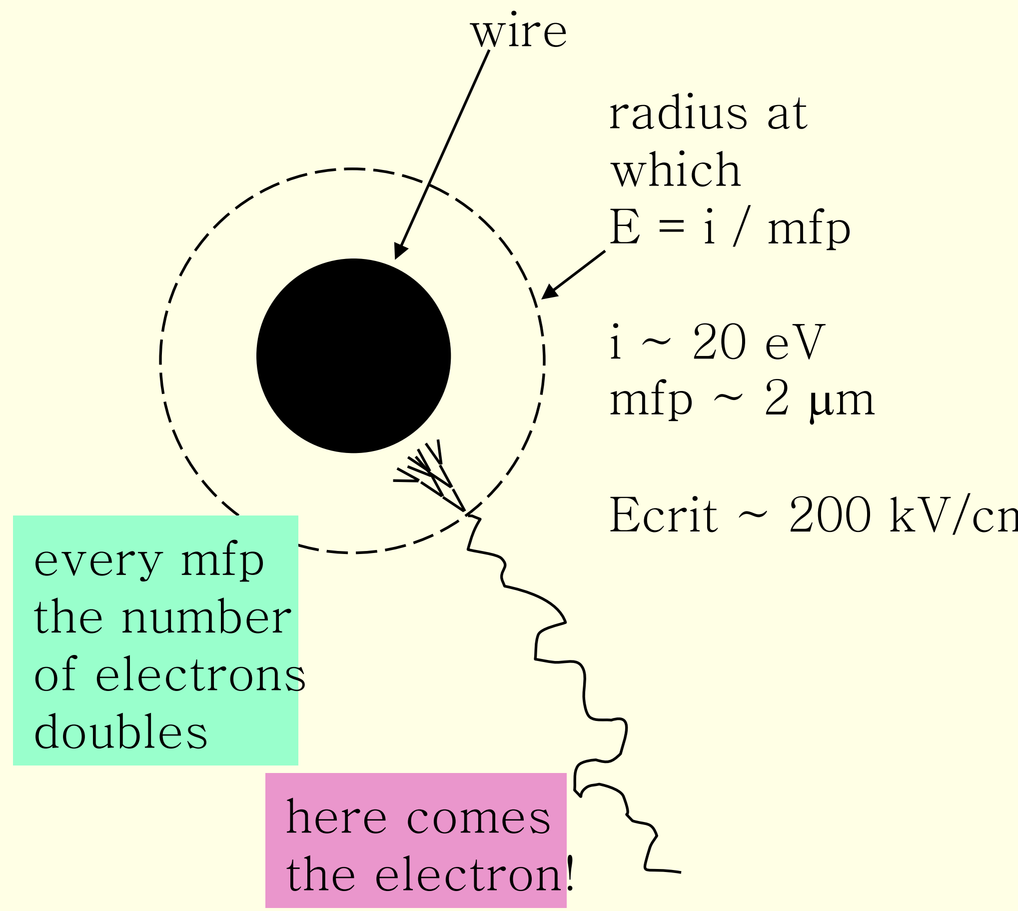


the “avalanche” (cont.)

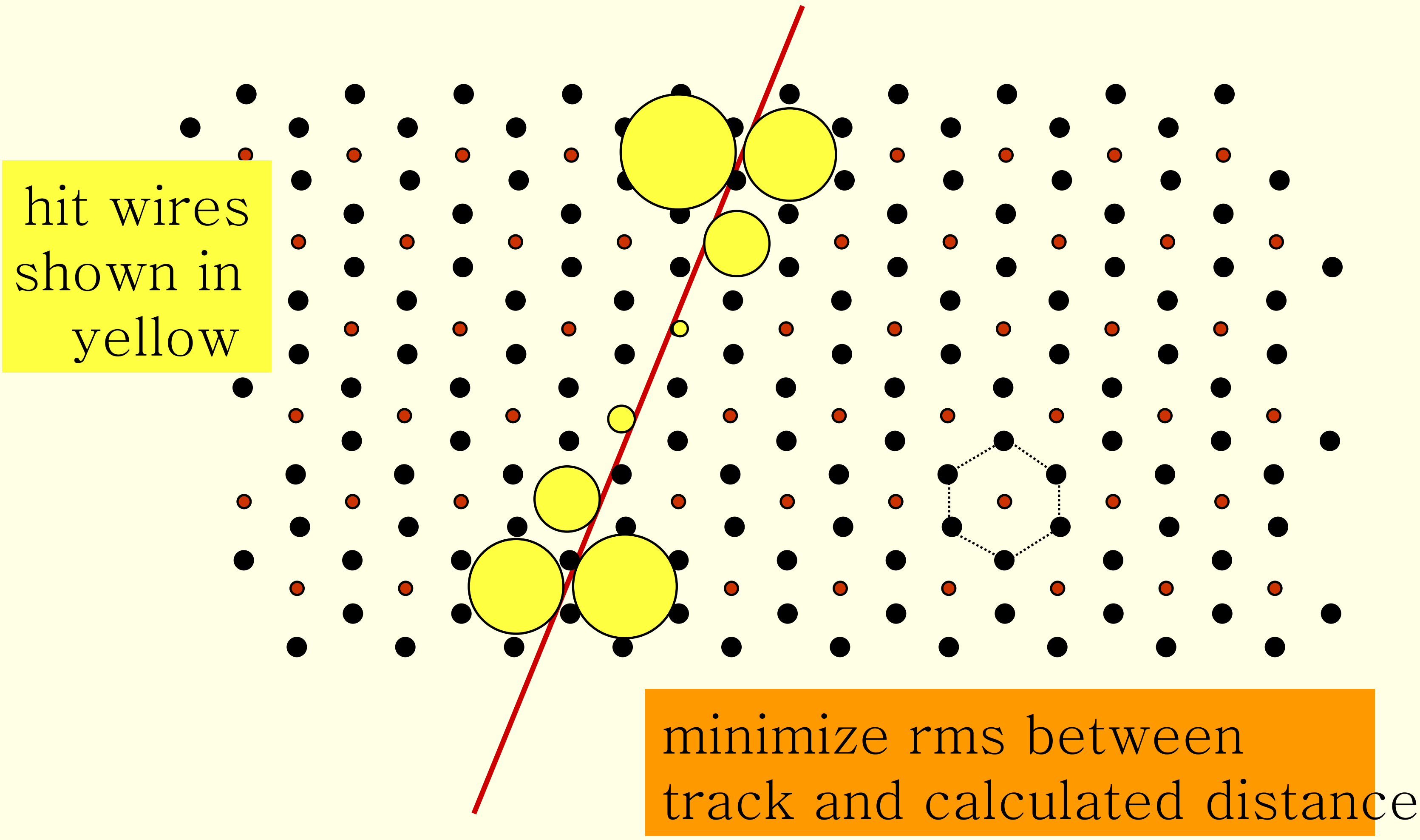
gain ~ $2^{\mathbf{ndbl}}$
ndbl = $(r_{crit} - r_{wire})$/mfp
Ecrit = $k * V / r_{crit}$

gain ~ 2^{k*V}

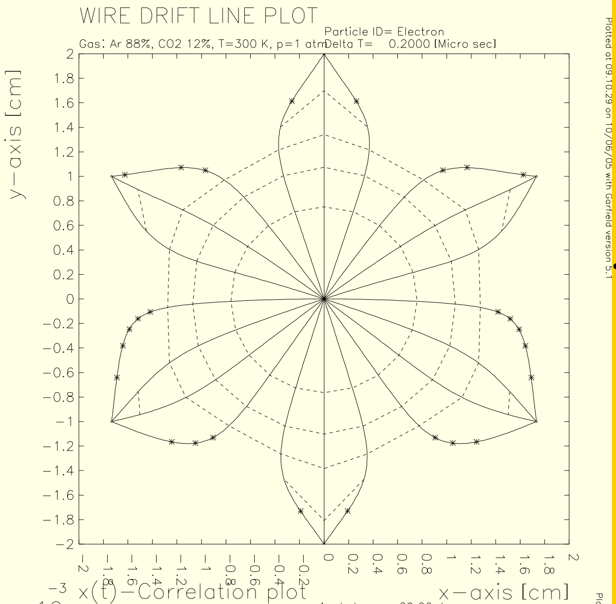
rule of thumb:
gain doubles every
75 or 100 Volts

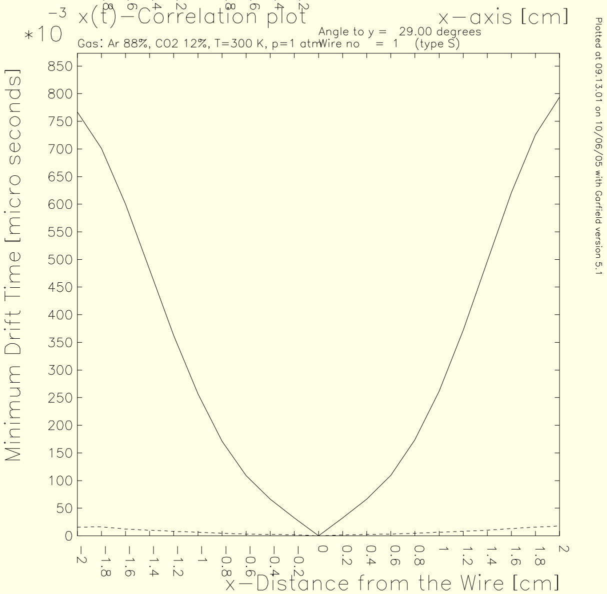


how tracking works



Drift Velocity Calculation





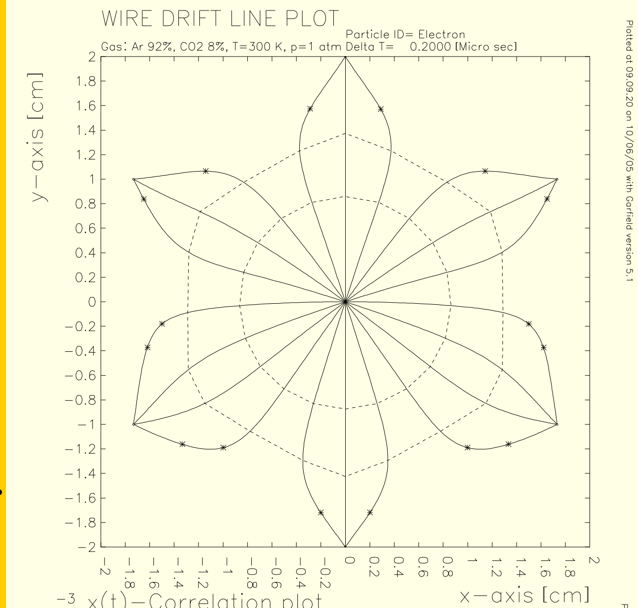
20 μm wire
2325 V
88:12 AR:CO_2

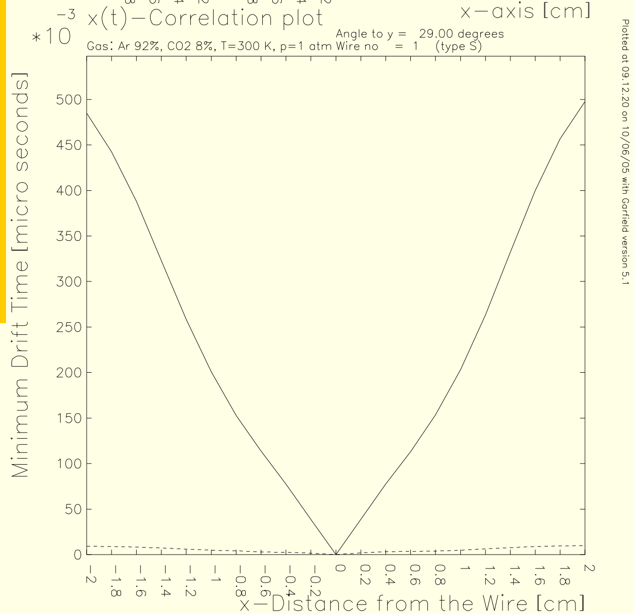
30 μm wire
2475 V
92:08 AR:CO_2

← same gain →

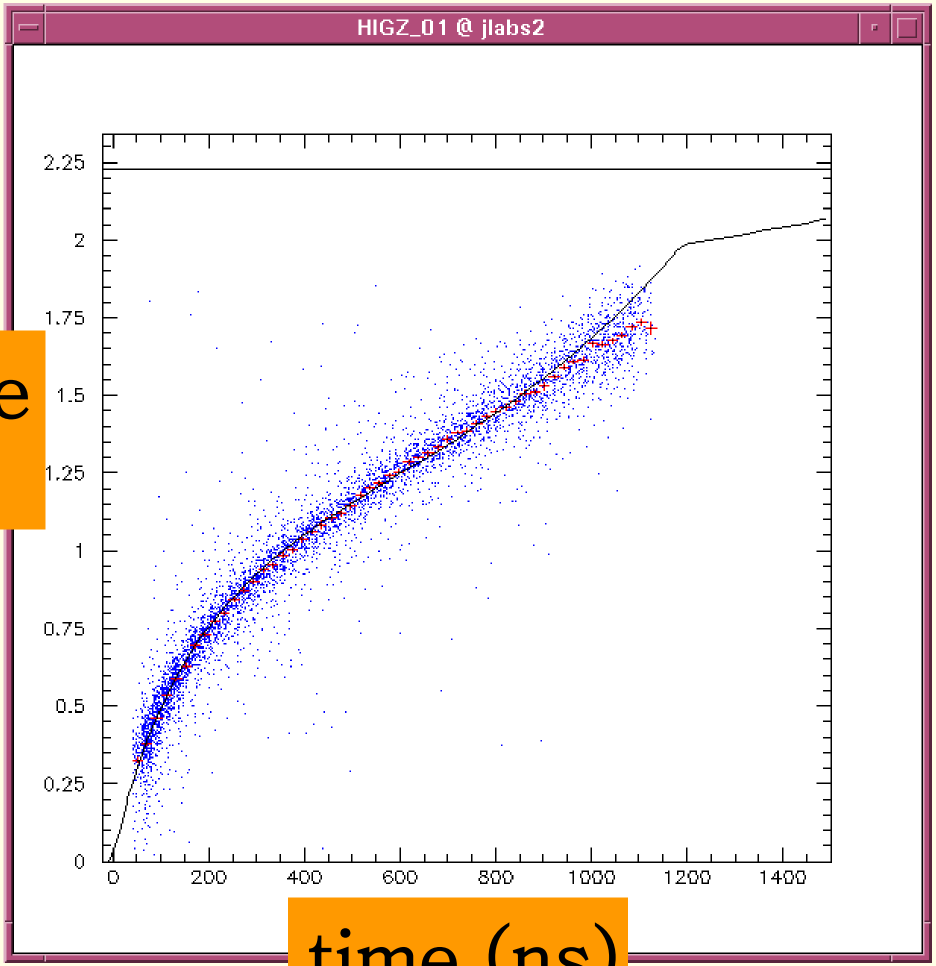
58% faster ⇒

- and more linear !





drift velocity calibration



distance (cm)

time (ns)

Installing Pre-tensioning Wires

Pre-tensioning
- before we start stringing
- use springs on guard wires
- gradual release of tension

- Operating successfully for ~10 years ….

FAQ's (your turn!)

efficiency vs. noise trade-off

drift time calibration

magnetic field effects

Malter effect

fast gas

cathode emission

material choices: wires, endplates

quenching gas

reference books

HV plateau